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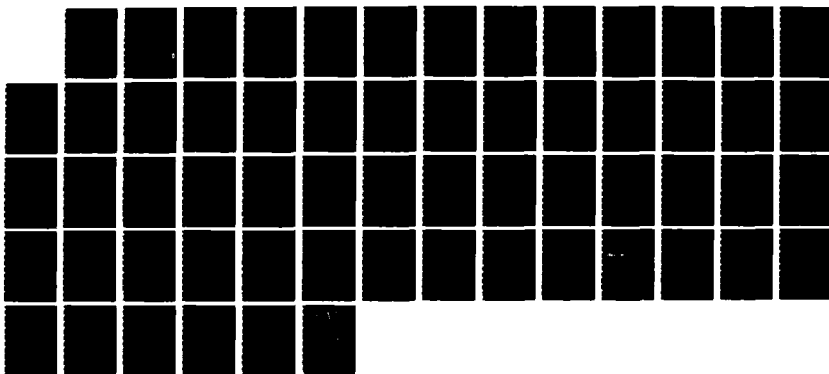
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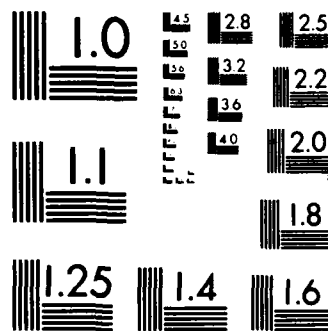
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SUSTAINMENT IMPROVISATION - EXPANDING THE REALM  
OF THE POSSIBLE

by

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School of Advanced Military Studies  
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Fort Leavenworth, Kansas

8 May 1987

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In each case appropriate detail is presented to create a broad picture of the effort, techniques, and procedures employed to create and operate the improvisation. Significant problems and costs associated with the operation are highlighted to illustrate some of the challenges that can be expected when improvising sustainment. Specific focus is placed on why sustainment improvisation was required operationally. Reaction time and duration are analyzed. The command and control aspects of the improvisation are explored to determine at what level the decision was made for initiating the action and who controlled the sustainment operation during its life span. The operational role and impact of the sustainment improvisation is analyzed to determine how the improvisation expanded the realm of the possible. Opinions are expressed for whether or not the improvisation was worth the cost.

Findings, lessons learned, shared characteristics, and implications are presented to better prepare future sustainment improvisers when they are challenged to expand the realm of the possible. Some of the shared characteristics include the inevitability of the need to improvise, the large magnitude in time and resources required for operational level improvisation, the high risks involved, and the common shortfalls in transportation. Implications for the future show that sustainment improvisation at the operational level may be required routinely due to force structure constraints, worldwide mission requirements, unpredictability of future conflict, and increased consumption rates. Commanders and subordinates must practice creative thinking, innovative problem solving, and be prepared to take prudent risks to expand the realm of the possible through sustainment improvisation.

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## ABSTRACT

SUSTAINMENT IMPROVISATION - EXPANDING THE REALM OF THE POSSIBLE  
by MAJ Randolph B. Wehner, USA, 56 pages.

This monograph investigates historical examples of sustainment improvisation at the operational level to determine the role sustainment improvisation has played in the conduct of the operational art of war and the significance of improvisation for future operational sustainment planners.

First, twentieth century improvisation examples are described with a general situation. The examples from World War II include the aerial Hump operation in the China-Burma-India Theater, the logistics-over-the-shore (LOTS) operations with the Normandy Beach landings, and the system of express highway routes to include the Red Ball Express. More recent examples from Vietnam include the civilian contracting of terminal services and a modern aerial Red Ball Express for high priority parts resupply.

In each case appropriate detail is presented to create a broad picture of the effort, techniques, and procedures employed to create and operate the improvisation. Significant problems and costs associated with the operation are highlighted to illustrate some of the challenges that can be expected when improvising sustainment. Specific focus is placed on why sustainment improvisation was required operationally. Reaction time and duration are analyzed. The command and control aspects of the improvisation are explored to determine at what level the decision was made for initiating the action and who controlled the sustainment operation during its life span. The operational role and impact of the sustainment improvisation is analyzed to determine how the improvisation expanded the realm of the possible. Opinions are expressed for whether or not the improvisation was worth the cost.

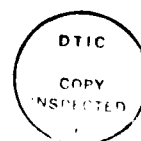
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## SUSTAINMENT IMPROVISATION - EXPANDING THE REALM OF THE POSSIBLE

### INTRODUCTION

Shifting political constellations and changing operational situations have probably prevented the vast majority of past commanders from conducting their wars with anything resembling the number and type of resources they would ideally like to have. This has meant that commanders have needed certain personal qualities, such as adaptability, resourcefulness, ability to improvise [emphasis added] . . . (1)

Martin Van Creveld  
Supplying War

The ability to adapt and to improvise [emphasis added] are just as important to the logistic forces as to the combat forces . . . (2)

Henry E. Eccles  
Logistics in the National Defense

Von Moltke has said that no plan survives contact with the enemy. Since history seems to support this idea no matter how well operations are planned, what is the operational level logistics planner supposed to do to prepare for sustaining unpredictable contact with the enemy? The U.S. Army has developed doctrine to help the logistician meet the sustainment challenges of AirLand Battle. The U.S. Army's capstone doctrine manual, FM 100-5, Operations, and FM 100-10 (Draft) Combat Service Support, the Army's capstone sustainment manual, both specify improvisation as a fundamental sustainment imperative. FM 100-5 recognizes that:

No matter how carefully commanders and planners try to anticipate events, unforeseen contingencies arise in every conflict. Enemy action, interruptions of sealift or airlift, and natural disasters can all upset plans and require improvisation. [In the past,] CSS [combat service support] planners and operators have had to improvise to meet unanticipated emergencies. In such situations, normal operating procedures must be suspended, unusual sources of

supplies and transportation exploited, and exceptional risks accepted . . . Such improvisation has long been one of the American soldier's greatest strengths and should be viewed as an advantage in meeting emergencies. [Emphasis added] (3)

FM 100-10 (Draft) additionally highlights improvisation:

. . . A historical strength of the American soldier is improvisation. He has taken problems and unexpected setbacks in stride. That improvisation must be a hallmark of CSS . . . Nothing is sure in war; the best plans are thwarted by unforeseeable events. These events usually require emergency measures and diversions from normal plans and procedures. (4)

While these descriptions focus on reactive or crisis improvisation such as in an emergency or sudden change of mission with extremely short reaction time, there is another type of improvisation -- proactive or deliberate improvisation. Proactive improvisation is seen in history when the operational sustainment planner anticipates a shortfall and with more reaction time develops an improvised solution where none existed previously.

FM 100-10 (Draft) alludes to this within its section on improvisation:

Supporters must seek new, innovative solutions to problems. Bold, imaginative methods [must be] developed. The routine and the traditional must be discarded if they will not solve a problem. Extraordinary methods may be necessary to get things done. (5)

Even if FM 100-5 and FM 100-10 had not highlighted sustainment improvisation, it is still vitally important for an operational planner to appreciate what has been improvised in history and to consider the special new demands the future may hold. The study of history shows how the realm of the possible was at times expanded further than anybody might have expected, and helps prepare for what could be required to support future operations.

Sustainment improvisation at the operational level is what this monograph is about. It attempts to answer the questions: what role has sustainment improvisation played in the conduct of the operational art of war and what is the significance of improvisation for future operational sustainment planners. In pursuing answers to these questions, the basic definitions of operational art and operational sustainment, and who is involved come from FM 100-5. This field manual uses operational art to describe the practice of war which links the strategic and tactical levels of war:

Operational art is the employment of military forces to attain strategic goals in a theater of war or theater of operations through the design, organization, and conduct of campaigns and major operations. . . . Operational art sets the objectives and pattern of military activities. . . . (6)

Important for further discussion is an understanding of the broad range of hierarchies of command which deal with the operational art. FM 100-5 states that:

. . . No particular echelon of command is solely or uniquely concerned with operational art but theater commanders and their chief subordinates usually plan and direct campaigns. Army groups and armies normally design the major ground operations of a campaign. And corps and divisions normally execute those major ground operations. (7)

Finally, while there is no precise definition, FM 100-5 describes operational sustainment as:

. . . those logistical and support activities required to sustain campaigns and major operations within a theater of operations. Operational sustainment extends from the theater sustaining base or bases which link strategic to theater support functions, to the forward CSS units and facilities organic to major tactical formations. (8)

With this doctrinal background, it should be clear that operational art and operational sustainment not only link strategy and tactics but they also overlap activities of both; operational art/sustainment translates strategic goals and objectives into tactical activities, and tactical activities are the tools the operational artist uses to achieve the strategic goals and objectives. Therefore, the reader should be aware that some improvisations which directly play a role in the operational art may occur at the strategic level and some may occur at the tactical level of war. Improvisation is important at any level and can have a far reaching effect, regardless of the level of activity -- strategic, operational, or tactical -- at which it occurs.

#### METHODOLOGY

To investigate sustainment improvisation's role in the operational art, historical improvisation examples are described with a general situation. Appropriate detail is presented to create a broad picture of the effort, techniques, and procedures employed to create and operate the improvisation. Significant problems and costs associated with the operation are highlighted to illustrate some of the challenges that can be expected when improvising sustainment.

Specific focus is on why sustainment improvisation was required operationally. For instance, was there a crisis action like the unexpected success of Patton's Third Army or was the

improvisation more deliberate like the Mulberry construction? Reaction time and duration are analyzed.

The paper explores the command and control (C2) aspects of the improvisation to determine at what level the decision was made for initiating the action and who controlled the sustainment operation during its life span.

The monograph attempts to determine and analyze the operational role and impact, both positive and negative, of the sustainment improvisation. It also analyzes the question of how the improvisation expanded the realm of the possible. It offers opinions about whether or not the improvisation was worth the cost in men, materials, and other resources. It also analyzes the sustainment improvisations for any common relationships. Finally, it presents appropriate findings, lessons learned, and implications to prepare future sustainment improvisers when they are challenged to expand the realm of the possible.

#### HISTORICAL BACKGROUND

U.S. wartime history in the twentieth century contains many examples of operational sustainment improvisation. During World War II, the China-Burma-India (CBI) Theater had the first highly visible large scale improvisation for U.S. forces. The Hump operation, the only sustainment link between India and Allied forces in China operated at a high cost in lives and equipment, but with great military operational and political success.

In the European Theater of Operations, the Normandy landings utilized improvised sheltered harbors created with sunken ships and portable ports known as Mulberries to conduct logistics-over-the-shore (LOTS) operations. The early Allied successes and rapid pursuit across France would have been impossible without this LOTS sustainment since deep water ports were captured later than expected. The pursuit phase of this Normandy Campaign was made possible with one of the most famous operational sustainment improvisations of all--the Red Ball Express. This operation was the foundation for several other express highway routes all of which expanded operational possibilities.

Twenty years later, in the 1960's, we would be improvising sustainment for the Vietnam conflict. Port facilities in Vietnam were seriously overcrowded with the build up of forces. Civilian contractors were hired to handle terminal services. Shipping delays in processing requisitions, the complexity of new equipment and the harsh tropical environment of Vietnam meant a reduction in weapon system availability and an increase in the demand for repair parts. To offset this increased urgent demand for parts, a special air delivery Red Ball Express was improvised to sustain the most critical weapon systems.

All of these operational examples of sustainment improvisation have unique details and circumstances that make them worthy of study. They also have a common characteristic, in that they all involve elements of a transportation system. This should not be surprising since virtually all functions of operational

sustainment are dependent upon distribution or transportation capabilities. The noted logistics historian James A. Huston, writing in The Sinews of War: Army Logistics 1775-1953 recognizes the power of transportation's influence on sustainment:

Probably the most common limiting factor in U.S. Army logistics has been transportation. Whenever shortages of supplies or equipment have appeared at the battle fronts, from the Revolutionary War to the Korean War, more often than not it has been the result of some shortage in transportation somewhere along the line.

While transportation might be the most general limiting factor on logistics as a whole, the limitations of transportation itself might be determined by a small segment of the total transportation system -- shipping, port facilities, roads, railroads, vehicles, or other facilities . . . Generally most transportation difficulties for U.S. Army forces have been found within the theaters of war . . . (9)

In addition to this transportation commonality, each of the historical improvisation examples expanded the realm of the possible in operational capabilities.

#### CHINA-BURMA-INDIA

China became vital strategically and operationally after the December 1941 Japanese offensive both as an ally and as the base for a future counterattack against Japan. The Chinese forces, though poorly trained and equipped, nevertheless forced Japanese ground forces to be committed in China as opposed to other more critical areas in the Pacific. Japan had successfully isolated all of China by sea and after Rangoon fell in March and Lashio fell in May 1942 the supply flow by land over the Burma Road ended. (10)



Prior to Burma's fall, President Roosevelt had received information from the Chinese Foreign Minister early in February 1942 which forecasted the eventual closure of the Burma Road and the isolation of China. When the inevitable happened, the President reassured the Chinese:

The Japanese may have cut the Burma Road, but I want to say to the gallant people of China that no matter what advances the Japanese may make, ways will be found to deliver airplanes and munitions to the armies of China. We remember that the Chinese people were the first to stand up and fight against the aggressors in this war. (11)

Roosevelt had already addressed the problem of supplying China in a tasking letter to General George C. Marshall, the Army Chief of Staff, on 25 February 1942: "It is obviously of the utmost urgency . . . that the pathway to China be kept open." (12)

To keep "the pathway to China" open, the United States selected Lieutenant General Joseph Stilwell to be the American Commander in the CBI Theater of Operations. The War Department ordered Stilwell to "assist in improving the combat efficiency of the Chinese Army" and Marshall broadened the tasking guidance when he emphatically told Stilwell: "Support China." (13) All of this guidance for Stilwell came in February 1942 and included the mission to improvise an air sustainment link even before China was isolated. Stilwell wrote in his diary after he received his orders and verbal guidance:

Events are forcing all concerned to see the importance of Burma. We must get the air line (Hump) going at once and also build backcountry roads. (14)

Besides sending Stilwell, the United States Government had already been providing part of 100 million dollars in lend-lease supplies and equipment to China since 1941. (15) This amounted to well over a hundred thousand tons of cargo and delivery of lend-lease cargo would be the first use of the fledgling Hump air line.

Stilwell gave the unprecedented mission to improvise sustenance by air to the United States Army Air Force's Tenth Air Force which was under his control in the theater. The initial plan involved building up China's National Aviation Corporation (CNAC) fleet of aircraft. Simultaneously the Army Air Force (AAF) was planning air resupply from Assam over the mountains of North Burma to Myitkyina on the Irrawady River (see map 1 on page 41). Unfortunately, by June 1942 only ten aircraft had augmented CNAC and Japanese ground forces had overrun the airfield at Myitkyina. The only solution remaining was for American pilots to fly from Assam airfields across the "Hump" of the Himalaya Mountains to Kunming, or Yunnanyi, China. The first American flight was in April 1942.

The initial mandated objective was to supply 4,000 tons of cargo a month to support the Chinese Army and the China Air Task Force. In May 1943 during the TRIDENT conference, President Roosevelt ordered an increase in monthly Hump tonnage to 7,000 tons by July and 10,000 tons monthly starting in September 1943. (16) These increases were in response to Chinese pleadings for more support and the expanding needs of the U.S. China Air Task

Force and General Stilwell's ground operations. But by July 1943 only about half of the President's ordered increase could be met.

In 1944 there was a great augmentation of the Hump effort, and Stilwell had captured Myitkyna Airfield which permitted a more southerly, safer Hump route so that by July 1945 a peak Hump monthly record of 71,042 tons of cargo from India to China was attained. Finally in November 1945 the Hump operation officially ended with a total of over 180,000 missions flown delivering over 650,000 tons of gasoline, ammunition, lend-lease equipment and supplies in 43 months. (17)

All of the legendary achievements of the improvised Hump sustainment operation were not accomplished without a cost in men and materiel. Inexperienced crews, poor facilities, unreliable aircraft (the Consolidated C-109 and C-87 aircraft had an accident rate 500 percent higher than other aircraft) (18) and the treacherous environmental conditions contributed to a high accident rate. For example, in one seven month period from June to December 1943, there were 155 major accidents on the Hump route causing 168 crew fatalities. (19) However, because of increasing experience, better equipment and improved safety measures the accident rate per flying hour was reduced over 80% by July 1945. (20)

#### China-Burma-India Analysis

The Hump airlift operation is an example of a reactive improvisation mounted in a sudden crisis--the 1942 Allied defeat in Burma and the subsequent closure of the Burma Road. This road

had been both the link between China and her allies and the supply route for Army Air Force elements based in China. The initial improvisation responded quickly to the need for airlift but fell short of the high tonnage requirements for several months.

The Hump operation expanded the realm of the possible for the CBI campaign. It was the airlift sustainment effort that made victory against the Japanese possible, helped save China, and prohibited Japanese diversion of forces to counter the successful United States Pacific Island campaign. An Air Force historian describes the operational impact of the Hump operation:

More important, the Hump airlift made possible the continued resistance in China . . . Without these supplies the defense of China would not have been possible. As it was, the allies in China were able to avoid being crushed by Japanese military might. The Japanese imperial Army was forced to maintain 1.2 million troops and uncounted numbers of valuable resources on the Chinese mainland. Had it achieved a quick victory there, Japan could have left a small occupation force in China and moved the remainder of its force to oppose the Americans in the Pacific, perhaps making the island-hopping campaigns more costly than they were. (21)

Despite all of its remarkable achievements, the Hump Operation had command and control (C2) problems which fell into two categories: C2 of the actual tonnage allocations and C2 of the resources of the Hump airlift. First, tonnage allocation decisions made by the President at the 1943 TRIDENT conference created a dilemma for all operational customers of the Hump airlift. The amount of limited Hump supplies allotted Brigadier General Chennault in China was insufficient to support major air operations and the remaining share of tonnage was inadequate to

bolster ground operations. (22) While trying to appease everybody, no one was satisfied and the tremendous operational potential of an improvised sustainment effort was diluted to ineffectiveness. This highlights a C2 lesson for sustainment improvisation: priorities must be clearly delineated and leaders must be educated on requirements and limitations of any improvisation system to achieve maximum benefit.

Command and control of the resources of the Hump airlift initially rested with the Army Air Force's Tenth Air Force, located in India, after CNAC couldn't handle the massive cargo tonnages. In October 1942, Hump C2 shifted to the Air Transport Command (ATC) which was deemed more experienced in this type of ferrying operation and was considered the best headquarters to manage a large scale airlift. ATC maintained the Hump C2 for the duration of the airlift. The turbulence in C2 from March until October 1942 illustrates the uncertainty associated with such a massive improvised effort and the consequent need to be flexible, experiment, gain experience, and adjust C2 to find the optimum arrangement.

Stilwell developed a campaign plan to reestablish the ground link between India and China through Burma. He planned on a converging attack with his Chinese X-Force, which he was training in India, to attack into Burma from the west along with the British forces. The attack from the east was to be the American trained and lend-lease equipped Chinese Y-Force with air support

provided by Chennault. The official Army historians Romanus and Sunderland wrote about the impact of the Hump on this campaign:

Tying together the Indian and Chinese halves of this great expanse of Asia were about fifty transport aircraft which flew between Assam and Yunnan airfields, the whole operation known colloquially as the Hump. (23)

Clearly the Hump expanded Stilwell's realm of the possible by making a converging attack possible.

Stilwell had further developed a plan for revitalizing another thirty Chinese division Z-Force to handle Japanese opposition in eastern China. This force would have been entirely supported by Hump tonnage, but the Chinese continuously delayed this force's development and let Chennault's Fourteenth Air Force now in China do the bulk of the fighting in the east for them. The Fourteenth Air Force, however, was also supplied completely by Hump tonnage, so the successful defense and limited offense against the Japanese in China was all attributable to the Hump improvisation.

When Stilwell's northern Burma campaign achieved success in reopening a land LOC through Burma to China, it was done almost entirely by forces from the Indian side of the theater. Chinese politics and footdragging delayed the commitment of the eastern Y-Force. Significant, however, is that even with the land LOC, Stilwell Road, reopened, the importance of Hump air supply tonnage did not diminish. Out of over 91,000 tons shipped into China during July 1945, over 73,000 tons (80%) still was delivered by the Hump sustainment improvisation. (24)

Not only did the airlift sustain combat needs such as ammunition, petroleum products, weapons and soldiers, but also the human survival needs such as food and medicine. Literally everything soldiers and their commanders needed went by air. No other special air sustainment effort

. . . was the sole means by which a combat theater was nourished. . . . every vehicle, every gallon of fuel, every weapon, every round of ammunition, every typewriter, and every ream of paper which found its way to Free China for either the Chinese or the American forces during nearly three years of war was flown in by or from India. (25)

To assess the impact it is appropriate to quote the official Air Force historians, Craven and Cates, as they answer the question of whether or not this largest, most costly sustainment improvisation ever attempted was worth the cost in men's lives, money and materiel:

. . . it can be urged (SIC) that the regime of Chiang Kai-shek would have collapsed without the support of General Chennault's command and that Chennault's men were wholly dependent upon the Hump lift. It can be argued that it helped to prevent the Japanese from overrunning all of China and preserved for the forces of the United Nations a base for launching an air attack upon Japanese shipping, upon vital Japanese industrial installations in eastern China, upon Formosa, and even upon the Japanese homeland. Thus it may have speeded somewhat the conclusion of hostilities against Japan . . . (26)

With all of the Hump successes, and despite the costs, the future of airlift was assured. Craven and Cates best summarize the Hump operation's future impact:

Here the AAF demonstrated conclusively that a vast quantity of cargo could be delivered by air, even under the most unfavorable circumstances. . . . In military and civilian circles alike men were forced to modify their thinking regarding the potential of airlift. The India-China experience made it possible to conceive the Berlin airlift of 1948-49 and to operate it successfully. When the Korean War in 1950 required the emergency delivery of

large numbers of men and equipment to the Far East, the precedents and the techniques for doing so were at hand. (27)

### EUROPEAN THEATER OF OPERATIONS

Sustainment improvisation on a grand scale was used not only in the CBI Theater of Operations in World War II, but also in the European Theater of Operations (ETO). In ETO the positive impact of improvisation probably had the greatest effect on Allied victory in any conflict to that date. Two major operational level improvisations occurred. One, deliberate, involved the logistics- over-the-shore (LOTS) operation on the Normandy beaches. The other, a reactive improvisation, involved a series of express highway routes that had various color coded and alpha character names, the most famous of which was the Red Ball Express.

#### Normandy Beach Operations

The Allied invasion of Northwestern Europe required tremendous tonnages of supplies to be transported onto the continent to support first the 5 spearhead divisions and eventually 39 divisions. The Germans certainly recognized the importance of high sustainment tonnage requirements and never expected the Allies successfully to accomplish an invasion without a large port. They planned their coastal defenses accordingly. Every deep water port along the English Channel, northern France, and Belgium was thoroughly fortified and heavily manned. Hitler had given the defenders orders to defend to the last man. (28)



The Allies realized the existing ports would be unusable and early in the planning, confronted the challenge of how to get tons of supplies from deep draught ships miles off shore through unsheltered water and over the Normandy beaches. The problem was addressed at the highest level on the British side, when in May 1942 Prime Minister Churchill wrote to his Chief of Combined Operations,

. . . directing that a solution be found for the problem of special berthing facilities on the far shore. Suggesting piers which 'must float up and down with the tide,' he ordered: 'Don't argue the matter. The difficulties will argue for themselves!' (29)

British and American researchers began to improvise methods to meet the two major challenges of first, protecting harbor areas from the harsh channel waves by providing sheltered water, and second, operating beach and port facilities within these artificial harbors.

To create artificial harbors three different types of break-water devices were developed and employed. Two hundred foot long hollow cruciforms called LILOs and later renamed Bombardons were to be used as outer breakwaters. A system of block ships, which were damaged or obsolete merchant and naval vessels, were to be sunk in a row, with enough of the ships remaining above the water line to protect against the 21 foot tidal range. The third harbor improvement, the caisson, code named Phoenix, would prove to be the most extensive single effort in the plan for providing sheltered water. These were large (some were 60 x 200 x 56 feet), towable, and sinkable concrete boxes used to build a

deep-water breakwater. Sheltered water within a manmade improvised harbor was fairly assured.

The U.S. Navy came up with two reasonable solutions to the port problems. One solution used pontoons and pontoon ferries and the other solution utilized a spanned pierhead (also called Lobnitz piers) connected to flexible eighty foot floating pontoon bridge spans (nicknamed Whales). Both of these port systems worked and one U.S. Rear Admiral noted that, "When the history of World War II is written, it will record that the lowly pontoon played a significant role in virtually all of the major campaigns." (30) All of these portable port innovations collectively were called Mulberries. (See figure 1, page 42).

As with other improvisations there were costs associated with establishing sheltered water. The sheer effort that went into building caissons as part of the whole improvised harbor is noteworthy and illustrates the resources that may be associated with a massive improvisation. Caisson construction took from two to seven months working around-the-clock. Materials consumed included 545,000 cubic yards of reinforced concrete, 20,000 tons of timber, and 30,000 tons of reinforcing bars. Practically every yard, drydock, and basin in Southern England was utilized in construction, as well as every ocean going tug to tow the caissons to France. (31)

Not only were there high construction costs in the beach projects but also there was a price to be paid in reduced operation efficiency and cargo accountability. Because of the

delayed regular port operations, the continuing flow of inbound cargo, and the need to maximize the greater than expected capability of the improvised over-the-beach operations, a decision was made by the Navy on D+2 to unload all cargo regardless of its priority. (32) This decision, while exploiting the capabilities of a successful improvisation, repeatedly came back to haunt logisticians later when they had serious problems locating and accounting for desperately needed equipment and, in some cases, even units. This led to wasted time and materiel resources as duplicate requisitions had to be resubmitted, resulting in multiple handling and accumulation of excess supplies in the overcrowded beach storage areas. This is one case where a sustainment improvisation almost worked too well and forced logisticians to lose accountability and control.

#### Normandy Beach Analysis

The results of the deliberate improvisation efforts at getting supplies across the Normandy beaches were crucial for early allied operational success and ultimately for victory in Europe. More basically, the very plan for an amphibious landing on Normandy would have been impossible without the deliberately improvised LOTS capability. The chief of the COSSAC (Chief of Staff to Supreme Allied Commander) planning group recognized this improvisation's contribution when he wrote, "No responsible group of officers could ever have been found to approve the whole OVERLORD scheme if it had not been for the idea of Mulberry." (33)

Command and control issues had no serious negative effect on the improvised Normandy beach operations despite the turbulence in C2. Senior staff logisticians shifted between five different headquarters during beach operations. Planning responsibility shifted between seven different headquarters. There were early problems, however, as British and Americans tried to coordinate construction efforts, ports, and harbors. The solution to these problems appears to be combining operational C2 into one superior headquarters, a lesson reinforced on express highway routes later. (34)

The improvised artificial harbor became even more important than originally planned since the capture of the deepwater port at Cherbourg was delayed six weeks. Even after its capture it was several weeks before Cherbourg reached its planned capacity due to thorough German sabotage. Additionally every other deep water port on the Brittany coast was captured behind schedule--some took from two to five times longer than originally estimated. (35)

Initially several tactical operations such as 'Axehead,' 'Lucky Strike,' and 'Hands Up' had to be cancelled for logistical reasons because of the over-the-shore sustainment shortfall, but imagine how much worse the effect on operations would have been without at least the 71% capacity of total logistics flow made possible by the beach improvisations. Eventually, thanks to the beach operations, it was possible to land divisions ahead of

schedule starting at D+24. (36) These factors permitted a quicker allied response to the threat of German reinforcement and allowed the eventual Operation "Cobra" breakout to achieve success more rapidly.

Finally, one of the primary objectives of operation Overlord had been to establish a lodgement on the European continent from which further offensive operations could be developed. The improvised port and beach operations made this lodgement possible and provided a sustaining base for the forthcoming breakout and pursuit across France. The importance of these sustainment improvisations was acknowledged at the highest levels by the Supreme Commander, Allied Expeditionary Force, when General Eisenhower wrote,

. . . that the beach installations and the Mulberry . . . throughout the summer of 1944 . . . represented an essential factor in the success of our operations. Without them our armies could not have been adequately maintained in the field. (37)

#### Red Ball Express -- One of Many

Even with all of the costs in materials, manhours, and other resources, and the confusion and loss of accountability on the beaches, the Normandy beach and port improvisations stand out as a key contributor to Allied success. This first improvisation linked directly into another series of sustainment improvisations which supplied the faster than expected pursuit across France and eventual drive into Germany. A series of eight express highway routes originating near the Normandy beaches, ports, and later inland railheads, were improvised to satisfy special demands, to

exploit the faster than expected progress, to substitute for bomb damaged railways which took longer to repair than expected, and to help minimize any significant deficits in transportation for the field armies. The most significant routes were known as the Red Ball Express, the Red Lion Express Route, the ABC (Antwerp-Brussels-Charleroi) Express Route, and the XYZ Express Routes.

(38)

The most famous improvised express highway route was the Red Ball Express. This operation became the proving ground and laid the foundation for all the subsequent improvised routes which collectively contributed to maintaining operational momentum during the European campaigns. The Red Ball Express officially started on 25 August 1944 when the G-4, Communications Zone (COMMZ) gave the mission of moving 100,000 tons of assorted classes of supply to the Advance Section, a subcommand of the COMMZ providing closer support to the combat forces. Only 25,000 tons could be moved by rail, so the other 75,000 tons had to be trucked to meet a 1 September 1944 required delivery date for the continuation of the pursuit. The cargo had to be delivered from the Normandy beaches to the U.S. Army area in the Chartres-LaLoupe-Dreux area. The roads of Normandy couldn't support two-way traffic so a one way loop route was established. (See map 2, page 43). This improvised sustainment effort was eventually extended to a second phase because of its success and the continuing rail shortfall. In the beginning phase it utilized as many as 132 truck companies with almost 6,000 trucks. While the

1 September tonnage target was missed, by 5 September almost 89,000 tons of cargo had been moved and phase 1 officially ended. (39)

Phase 2 started 10 September 1944 and brought further extensions of the Red Ball Route, sometimes over 600 miles one-way. Routes eventually reached Hinson in the north supporting U.S. First Army and Sommesous in the south for U.S. Third Army. (See map 2, page 43) Phase 2 stretched sustainment improvisation even further when eight U.S. truck companies had to be withdrawn for the Red Lion Route. To replace these eight units on the Red Ball, provisionally improvised companies were formed with vehicles and inexperienced drivers from three divisions still at Normandy. By the time phase 2 ended on 16 November 1944, the Red Ball Express had hauled over 412,000 tons in 81 days. (40)

The next noteworthy successful express route was the Red Lion Route designed to support the combined U.S.--British airborne operations in Holland conducted by the 21st Army Group. This route hauled mostly POL 300 miles from Bayeaux to Brussels in its twenty-seven days of operation from September to October 1944. (See map 3, page 44) Eight U.S. truck companies, taken from the Red Ball Route as mentioned earlier, hauled a total of 18,000 tons. The U.S. drivers and vehicles were supported by British maintenance, life support, and highway regulation in this combined sustainment improvisation. (41)

With the opening of the port of Antwerp, yet another route, the ABC (Antwerp-Brussels-Charleroi or American-British-Canadian,

depending on source) Express Route was improvised to haul cargo from the port's limited storage area forward approximately ninety miles to the supply dumps for U.S. First and Ninth Armies in the Liege-Mons-Charleroi area. (See map 3, page 44). Regardless of the name chosen the operation utilized all American assets and was closely coordinated with the allies. Between 30 November 1944 and 26 March 1945, the ABC Express Route hauled 245,000 tons. (42)

The last improvised express highway route supported the final U.S. offensive beyond the Rhine River. This was a phased, flexible transportation haul operation planned to make up for widespread rail destruction and was known as the XYZ Express Route. Phase X handled 8,000 tons per day. Phase Y called for 10,000 tons per day, and phase Z delivered 12,000 tons per day. Four primary XYZ routes ran generally from the western border and originated in Liege for the U.S. Ninth Army, Duren for the U.S. First Army, Luxembourg for the U.S. Third Army, and in Nancy for the U.S. Seventh Army. (See map 4, page 45) The XYZ Routes commenced operations 25 March 1945 and handled 630,000 tons of cargo by V-E day on 8 May 1945, but were extended until the end of May to build up supplies for occupation forces. The total tonnage eventually reached 872,000 tons. At its peak operation XYZ employed the equivalent of 244 truck companies, which usurped three quarters of the motor transport in the entire Communications Zone. Just as with the Red Ball Express in the fall, when divisions were stripped of their vehicles and drivers, the Armies



had further to improvise by forming provisional truck companies from the organic trucking assets of anti-aircraft and field artillery units. Even though the Red Ball Express is more famous, the XYZ Express Route is considered the most successful route by some historians. Many of the lessons learned from previous improvised express highway routes, combined with the availability of more heavy duty trucks, resulted in a better organized, more efficient sustainment effort during the XYZ operations. (43)

As with previous types of improvisations, these super sustainment feats had associated risks, problems, and costs. Many problems were common throughout all of the express operations and some were unique to only one. Maintenance problems plagued all of the routes, but especially the early Red Ball Express. A conscious decision was made to postpone required maintenance as routes reached forward as far as 600 miles, and eventually the deadline rate soared along with the consumption of repair parts, tires, and oil. Contributing to maintenance problems were untrained and inexperienced drivers hastily organized into provisional companies, who did not know how properly to operate their vehicles and had no sense of ownership for their equipment. The driver fatigue factor of extended round-the-clock operations promoted accidents, malingering, and self-sabotage of equipment. Some cargo was sold on the black market. Communications and command and control difficulties plagued some operations. Material handling equipment shortages and transloading delays

caused some routes to be less efficient, while a shortage of the best type of heavy duty, larger capacity trucks, tractors, and semi-trailers constrained some of the improvisations. Fortunately progress was made and we learned from our mistakes so that by the time of the XYZ routes, improvised express routes were becoming more efficient and had fewer costs and constraints.

#### Express Highway Route Analysis

The early express highway routes initially represented examples of reactive improvisations that were organized on very short notice in an attempt to expand the realm of the possible. Commanders and logisticians profited from the value of these express routes, despite the costs and constraints. With more lead time available, they planned and designed deliberate or proactive improvisations such as the ABC and XYZ routes. The success of one improvisation spawned a whole series of express routes.

Command and control problems plagued the earlier routes, especially the Red Ball Express. One Communications Zone (COMMZ) section had responsibility for the route but the Motor Transport Brigade, an Advance Section (ADSEC) unit, operated the system. The route covered many COMMZ sections, all of which had various responsibilities to support the express system, and all placed different priorities on this support. Confusion and conflict plagued the C2 of the system until finally, in desperation, control was centralized at a higher echelon Motor Transport Service under the Chief of Transportation at the COMMZ. (44)

By the start of the ABC Express route in late November 1944, the C2 lesson of the Red Ball Express had been learned. The entire ABC system, though crossing national lines of communications, extending into ADSEC territory, and involving the joint use of logistics facilities by all American units, was centralized entirely under the control of a single base section commander of Channel Base. (45)

Command and control of the XYZ Express Route in March 1945 further employed the earlier C2 lessons and tightened control even more. All assets used in this route were assigned to one headquarters and headquarters company in the Motor Transport Service (MTS) which was commanded by a colonel who had C2 responsibility for the entire operation. To alleviate span of control problems and permit flexibility over the divergent multiple routes, highway transport divisions (HTD), which were to be central operating agencies in the field, were invented just for XYZ.

Improvised express highway routes were tremendous in their overall accomplishments and ability to expand the realm of the possible at the operational level during campaigns on the European continent. Patton would not have gotten as far as fast as he did, the German penetration at the Battle of the Bulge would not have been pushed back eastward as quickly as it was, and the final offensive across the Rhine would have taken much longer without improvised methods of quickly getting large tonnages out of the ports and forward to the armies to avoid waiting months for railways and inland waterways to be repaired.

Field Marshall Montgomery acknowledge the value and flexibility of the whole improvised sustainment system when he wrote,

Speedy regrouping on the Twelfth U.S. Army Group front, combined with outstanding administrative [British term for supply] improvisation, enabled the advance eastwards of the Third U.S. Army to continue while the battle of the Falaise pocket was still in progress. [Emphasis is Montgomery's] (46)

Not only did Montgomery recognize the contribution of sustainment improvisation on the beaches and on the express highway routes in expanding the realm of the possible, but General Eisenhower, the Supreme Allied Commander did also. Describing the impact of problems of supply and delayed opening of the Brittany ports, Eisenhower said in his report to the Combined Chiefs of Staff,

Within France the organization of our supply system did not present any major problems until our armies achieved their breakthrough. . . . When the breakthrough came, however, a great strain was imposed upon the maintenance [supply] system. . . . This [delay in capture of Brittany ports] meant that we had to rely for our maintenance at a most vital period of the campaign upon the original supply lines through Cherbourg, the Arromanches Mulberry, and the Normandy beaches. . . . The Third Army, when it got into its stride in the dash across France, was advancing at a speed of up to 40 miles a day, and our transport services were taxed to the limit. The incentive offered by the chance of a smashing victory, however, drove the men in whose hands the maintenance of supply rested to feats of superhuman accomplishment. . . . The spectacular nature of the advance was due in as great a measure to the men who drove the supply trucks as to those who drove the tanks. [Emphasis added] (47)

#### VIETNAM

From the very beginning of the Vietnam conflict, logisticians had a tremendous challenge. The terrain, climate, facilities, enemy situation, and command decisions all contributed to an unpredictable sustainment situation. Improvisation was to be

the standard operating procedure for satisfying many of the logistics requirements. First, a look at the Vietnamese environment.

The terrain of the Republic of Vietnam combines mountains to 8,000 feet in height and flat plains covered with savannah grass and jungle. The seacoast extends 1,500 miles with initially only one significant port, Saigon. The climate is tropical and monsoonal. The climate and terrain hampered movement, the operation and maintenance of equipment, and any efforts at construction of vital facilities needed in a logistics base.

There was an ubiquitous enemy who controlled the majority of the country. If the enemy did not directly control an area, he could easily interdict logistics operations through his guerrilla tactics. A United States Army, Vietnam logistics review board analyzed the tactical and security situation as follows:

. . . for the first time in modern history the Army was required to establish a major logistical base in a country where accessible areas were subject to continuous enemy observation and hostile fire, with no fixed areas under friendly control. (48)

The logistician's difficult mission was recognized by the chain of command. Nevertheless the tactical situation and response time dictated simultaneous deployments of logistical units and tactical units instead of the usual early establishment of an advance logistics base. General Westmoreland acknowledged the sustainment plight and the need for sustainment improvisation when he wrote about the Vietnam situation and his early decisions:

Consequently, there was no logistic system in being, and no development of secure logistic bases except the totally inadequate installations associated with the South Vietnamese forces. There were inadequate ports and airfields, no logistics organization, and no supply, transportation, or maintenance troops. Nonetheless, in the face of the grave tactical situation, I decided to accept combat troops as rapidly as they could be made available and to improvise their logistic support [emphasis added] . . . (49)

The logistician had unique sustainment problems in the Republic of Vietnam, but he was able to match the problems in most cases with good improvised solutions. One such improvised solution was commercial contracting of stevedore and trucking services as well as material handling equipment, large tug and other port services. This widespread use of civilian contractors in a combat zone was a first. Contractor support was initially necessitated in 1965 and 1966 by a large backlog of ships awaiting discharge in Republic of Vietnam ports. Commercial contractors performed so well that by 1969, over 70 percent of the stevedoring workload was being handled by civilians primarily at the ports of Saigon, Qui Nhon, and Cam Ranh Bay. Both Vietnamese and U.S. contractors were employed. (50)

Contracting port services helped expedite supplies into Vietnam, but did not solve early repair parts shortages for critical deadlined pieces of equipment such as aircraft, trucks, bulldozers, and material handling equipment (MHE). General Westmoreland commented to Secretary of Defense McNamara as he completed a visit to Vietnam in November 1965:

I need more repair parts support; I have 50 percent of my bulldozers down for parts, my MHE's [sic] are down for parts, my aircraft are down for parts, and you have got to help me. (51)

Within one month, logisticians in the United States had improvised the Red Ball Express (RBE) system, named after the extremely successful World War II express delivery system already described. RBE was an improved supply system that provided for intensive management procedures and expedited requisitioning and delivery of repair parts to maintain equipment in Vietnam at acceptable operationally ready (OR) rates. The Red Ball Express system's goal was to have repair parts arrive in Vietnam within seven days after the requisitions had arrived in the Continental United States (CONUS). Initially the system applied only to already deadlined items of equipment, but eventually, because of its success, RBE was expanded to cover repair parts that were anticipated to be needed to prevent deadlined equipment. One unique feature of this improvised sustainment system which set it apart from any other previous requisitioning system was that it could siphon parts directly from major end item assembly lines in CONUS or even initiate a special procurement if necessary. (52)

The costs of these Vietnam sustainment improvisations were minimal compared with the benefits realized. Mobilizing, shipping over, and sustaining military assets to accomplish the terminal service mission would have easily cost more than the civilian contractor using native Vietnamese laborers. The cost of the Red Ball Express was high initially with four dedicated aircraft but later, since plane loads of routine priority items were regularly coming to Vietnam, Red Ball items could easily bump these to a later scheduled flight. The main cost was the

version of the repair parts flow from other theaters and a consequent lowering of readiness--but Vietnam was the priority anyway. Assembly lines for equipment were occasionally interrupted, but no major impact was noted.

#### Vietnam Analysis

The two Vietnam sustainment improvisations, contracting services to civilians and establishing an air express sustainment pipeline for key items of equipment, were both reactive improvisations. They made it possible for General Westmoreland, at the operational level, "in the face of the grave tactical situation . . . to improvise . . . logistic support . . ." (53)

The most significant C2 issue for these improvisations was the RBE, which enjoyed high level visibility during its first year of operation because the Secretary of Defense required a weekly briefing on RBE status and performance. RBE C2, tracking, and distribution were centralized in one logistics office; and at supply levels below this, there was a designated RBE monitor. Both of these C2 techniques helped insure the RBE's success.

The contracting out of transportation and terminal services was much faster than a pure military solution of activating, training, and deploying other terminal service and truck units. It avoided political and public opinion problems in CONUS associated with activating reserve units. Civilian contracting of services allowed a higher percentage of total deployed forces to be combat troops at a time when overall force ceilings were lower and when a lower profile of U.S. involvement was



preferable. This improvised procedure avoided reducing both the military readiness of other regions and the readiness for various global contingency plans, by allowing the limited terminal service assets to stay in garrison locations. It avoided the wear and tear on low density military equipment. Contracting to civilians boosted the local Vietnamese economy as well as the U.S. economy, while saving on demurrage charges to the U.S. for the backlog of ships in the harbor. Since civilian contractors could respond faster, the port backlog of supplies and equipment got into the hands of the user quicker thereby improving overall U.S. readiness in Vietnam. Improvising by using civilian contractors for port services clearly expanded the realm of the possible for General Westmoreland and his forces.

Few sustainment improvisations have had such quantifiable results as the Red Ball Express system. Equipment of United States Army, Vietnam (USARV) maintained an average of 3 to 11% higher operationally ready (OR) rate than Department of the Army standards, while USARV equipment received approximately three times the usage rate of the rest of the Army worldwide. This phenomenal improvement in readiness occurred even while the density of the equipment eligible for RBE procedures increased anywhere from 50% to 125%. (54)

Early in the Vietnamese conflict the Red Ball Express impact was especially important, since critical items of equipment were at a lower density, consequently there was a greater impact on overall combat readiness when one item became inoperative. The

existence of the Red Ball Express allowed operational level planners to plan with more confidence knowing key equipment would meet or exceed OR rate standards consistently. The parts express also permitted a faster deadlined equipment rebound time between operations at all levels, which meant operational pauses could be shorter and pressure could be applied on the enemy more consistently. Every additional piece of equipment made operational by the RBE system meant a greater potential for success in field operations.

#### CONCLUSION

This monograph has looked at three different theaters of operation in the Twentieth Century with a focus on sustainment improvisation and its ability to expand the realm of the possible in the operational art of war. It is worthwhile to summarize key accomplishments and look for commonalities and lessons learned. The CBI Theater reactively improvised sustainment through an unproven airlift concept with an infant Army Air Force. By flying the Hump and sustaining otherwise isolated forces, this improvised airlift expanded the realm of the possible by keeping China in the war, helping regain Burma, diverting Japanese forces from more critical areas of operation, and proving the concept of massive improvised airlift for the future. This expansion of the possible was done while under constraints of a taxing environment, deficient equipment, shortages of parts, and lack of trained personnel. It was achieved at considerable expense in

lives and equipment. C2 of the Hump operation itself was turbulent until the best solution of utilizing the ATC was found. C2 of the Hump tonnage allocations and workload were often influenced by the President himself, occasionally with negative operational impact.

In the European Theater of Operations two major improvisations got the Allied forces and their supplies onto the continent and sustained their faster than expected pursuit across France and exploitation across the Rhine. The deliberately improvised Mulberry system made it possible for deep draught shipping to offload through sheltered water and over the beaches, in order to establish a lodgement without waiting on the much slower than anticipated port clearance. A reactive system of express highway routes expanded the realm of the possible for the Armies, especially Patton's Third, to keep constant pressure on the retreating Germans. Other express routes, literally covering from "A" to "Z," provided port clearance for Antwerp and a sustainment link as the Armies sped across the Rhine faster than rail lines could be repaired. The costs of these expansions of the possible were paid in thousand of construction manhours and millions of dollars in materials for the Mulberrys, and an overcrowded beach. The express highway routes paid in worn out equipment, exhausted drivers, and lost cargo. Risks were accepted as divisions were stripped of vehicles and drivers. C2 of beach preparation and operations was confused but workable.

C2 of the express highway routes matured from a decentralized, inefficient system to a more centralized, efficient XYZ Route.

In Vietnam civilian contractors for terminal services were utilized on a large scale in a reactive sustainment improvisation which reduced port backlogs, established an efficient port operation, and saved the politically unacceptable mobilization of Reserve Component units. Innovative logisticians improvised a reactive air express system to expedite parts for General Westmoreland's critically short items of equipment. The costs associated with these improvisations were minimal compared with previous historical examples. The most significant was the sacrifices in material readiness by other theaters and the consequent risk accepted. C2 of the air RBE was highly centralized and highly visible, which contributed to the improvisation's success.

These historical examples of sustainment improvisations displayed not only unique solutions to unique problems, but also several commonalities or shared characteristics which may be true for future improvisations. The first characteristic is the inevitability of the need to improvise to expand the realm of the possible. FM 100-5 recognizes, "No matter how carefully commanders and planners try to anticipate events, unforeseen contingencies arise in every conflict." [Emphasis added] (55). So it was in CBI when the Japanese made unexpected progress against a collapsing Chinese and British force and the Burma Road closed. Sustainment had to be improvised. So it was in ETO when

Third Army had unexpected operational success in its pursuit across the continent. Here sustainment had to be improvised, despite the tremendous meticulous planning effort that preceded Overlord. In Vietnam when U.S. equipment could not be maintained at an acceptable readiness level in the harsh climate, while depending on the normal supply systems, the RBE was improvised.

The next characteristic shared by sustainment improvisations at the operational level is their magnitude both in time and in resources. Hundreds of aircraft flying thousand of hours answered the challenge of sustaining an isolated multi-division Chinese force along with a U.S. air force for over three years. A huge expenditure of resources was required to improvise a system of deep water port facilities in ETO to get supplies for five divisions ashore in a hurry and sustain even more divisions later. Over a year of concentrated effort was involved in the Mulberry development. In Vietnam relatively few items of equipment like MHE and bulldozers caused very large problems when parts didn't arrive on time. It took Department of Defense influence to fix the parts problem for a few lines of vital equipment.

All of the sustainment improvisations involved high risk. Lives and equipment were risked with inexperienced air crews flying the treacherous route across the Hump. Three divisions in ETO were literally stripped of their vehicles and became immobile near the Normandy Beaches so that Patton could keep up his momentum against the retreating Germans. Using a priority air

express system to get parts to Vietnam ahead of most every other theater in the world meant accepting risk with the readiness decrement in these other areas.

Command and control methods differed in every sample of improvising, and in some instances had little discernible impact. One distinguishable characteristic, however, was the importance of unity of command. The Red Ball Express suffered from confused C2, but the XYZ Route profited from unity of command. The RBE for Vietnam was a great success because its C2 received such high visibility.

Throughout all of these case studies of sustainment improvisation and its effect on expanding the realm of the possible in the practice of operational art, one other common thread has been a transportation related shortfall needing to be fixed. Perhaps this weakest link in the sustainment chain can better be strengthened in the future. Finally, this study highlighted the tremendous potential for improvised sustainment to expand the realm of the possible and the vital role played by sustainment improvisation in the practice of the operational art of war in the Twentieth Century.

#### IMPLICATIONS

The future will be filled with opportunities for sustainment improvisation in expanding the realm of the possible in the practice of the operational art. Based on the expected conditions of the AirLand Battlefield and the present Army of Excellence (AOE)

constrained combat service support force structure, there will be many opportunities to improvise, because anticipated requirements greatly exceed current capabilities. The sustainment portion of the present AOE structure has been reduced allowing for less redundancy and placing more emphasis on technology such as automation and material handling equipment. Improvisation may be the only way to accomplish the mission.

The worldwide geographical expanse and terrain variety covered by the many U.S. interests and commitments mean that a force cannot be designed for every eventuality; in fact, the majority of our forces are general purpose and most likely won't fit every potential situation. Even if the forces did fit precisely, they might not be moved in time or in the right sequence because of our shortfalls in strategic airlift and sealift capability. It is wise to remember the historically recurring transportation shortfalls already analyzed. Improvisation may be the only way to make them fit or get the forces to their destination. Finally, fiscal and political constraints coupled with the increasing dependence on CSS assets in the Reserves mean that an operational planner will rarely have all of the sustainment forces or equipment he needs, especially if simultaneous operations are occurring in other theaters.

Many of the current constraints and shortfalls are known or can be accurately predicted. Based on this they can be wargamed, and anticipated, additional shortfalls identified, and the plan adjusted accordingly. This foreknowledge of sustainment

deficiencies is conducive to a deliberate or proactive sustainment improvisation such as the Mulberries at Normandy Beach.

What if the unexpected happens and the friction of war constricts the realm of the possible? Operational sustainers must have agility, flexibility, and creative powers to perform reactive or crisis action improvisations similar to the Hump airlift or express highway routes to expand the realm of the possible. Especially important is the need for operational commanders to be ready to accept the risks and costs, often high, associated with a reactive improvisation. For example, if all of the transportation assets are concentrated on one mission as with the Red Ball Express, commanders must be ready for the units with no transportation both to accept an economy of force role and to accept a readiness decrement in the well-used transportation once it is returned. Operational planners must use this time available to plan for deliberate improvisations wherever possible, but must always be flexible and creative enough to react to a need for sustainment improvisation.

To prepare for future sustainment improvisation requirements, Army schools should start early to train creative thinkers, capable of assessing and taking prudent risks. While in school, officers should study the lessons of history closely. Commanders in the field must encourage creative thinking, and innovative problem solving, support healthy risk taking, and



accept honest mistakes. These preparations will better prepare soldiers to meet the challenges of the future battlefield.

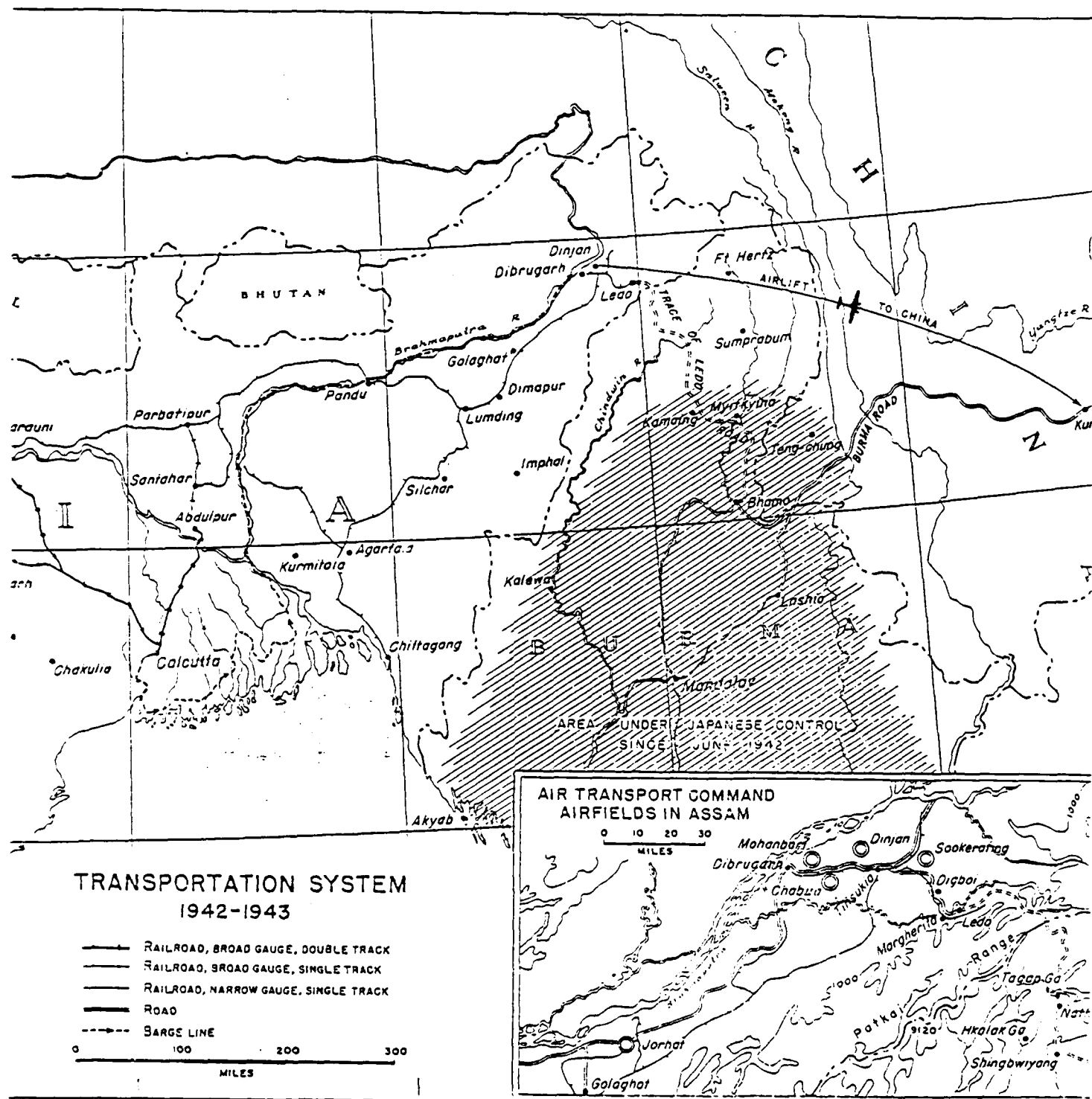
Implications for future sustainment improvisations must relate to what the future battlefield is expected to be like. FM 100-5 challenges future sustainers to be ready to operate on a battlefield that is:

enlarged, material-sensitive, electronically sensitive, and lethal . . . characterized by high consumption of military materiel; by a great diversity of equipment types; by the expansion of the battle area and by extended lines of support within and outside the theater of operations. [Emphasis original] (56)

FM 100-5 even uses the ETO Red Ball Express improvisation as a frame of reference for future expectations and to illustrate the extraordinary challenges to be expected:

During its August 1944 pursuit across France, for example, the U.S. Third Army consumed 350,000 gallons of gasoline every day. . . The Red Ball Express itself consumed 300,000 gallons of precious gasoline every day--nearly as much as a Field Army. Today, it is estimated that one armored division equipped with M1 tanks will consume over 600,000 gallons of fuel per day, more than twice the consumption of Patton's entire army. (57)

Technology has created consumption rates and greater sustainment demands such as above, and if the battlefield is as FM 100-5 has predicted, then operational sustainers must be ready to suspend normal operating procedures, exploit unusual sources of supplies and transportation and accept exceptional risks while exercising ". . . one of the American soldier's greatest strengths . . ." -- improvisation. (58) Or as FM 100-10 (Draft) asserts, ". . . improvisation must be a hallmark of CSS." (59)



MAP 1 ROUTE OF THE HUMP AIRLIFT AND AREA OF JAPANESE CONTROL OVER BURMA ROAD (60)

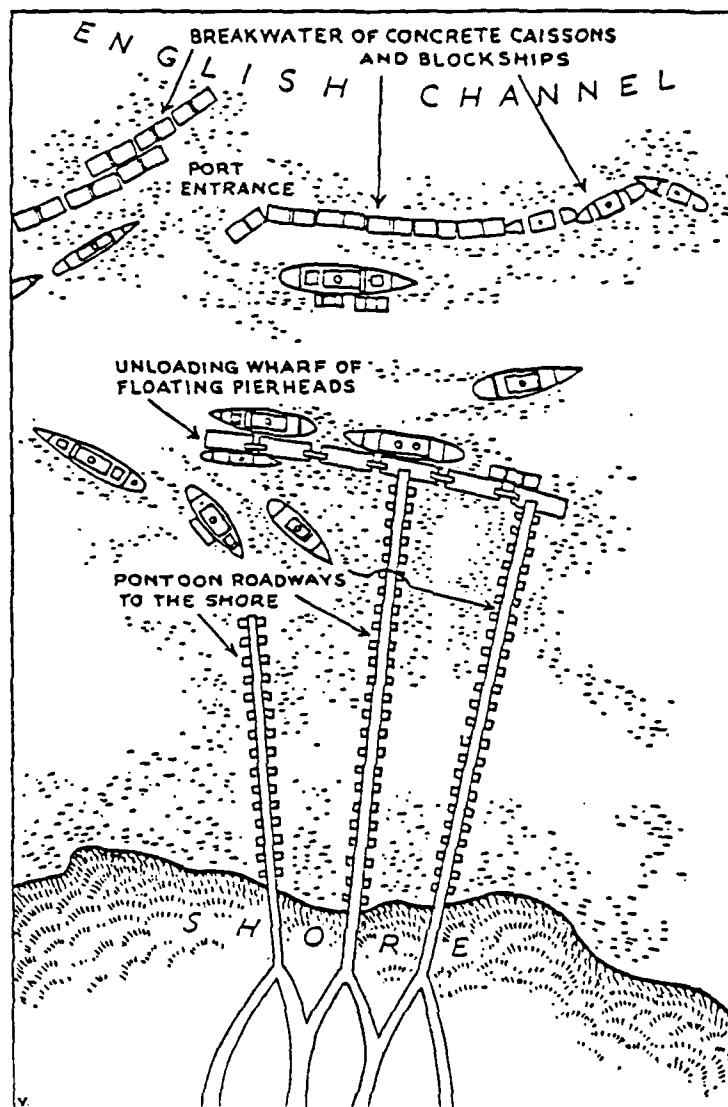
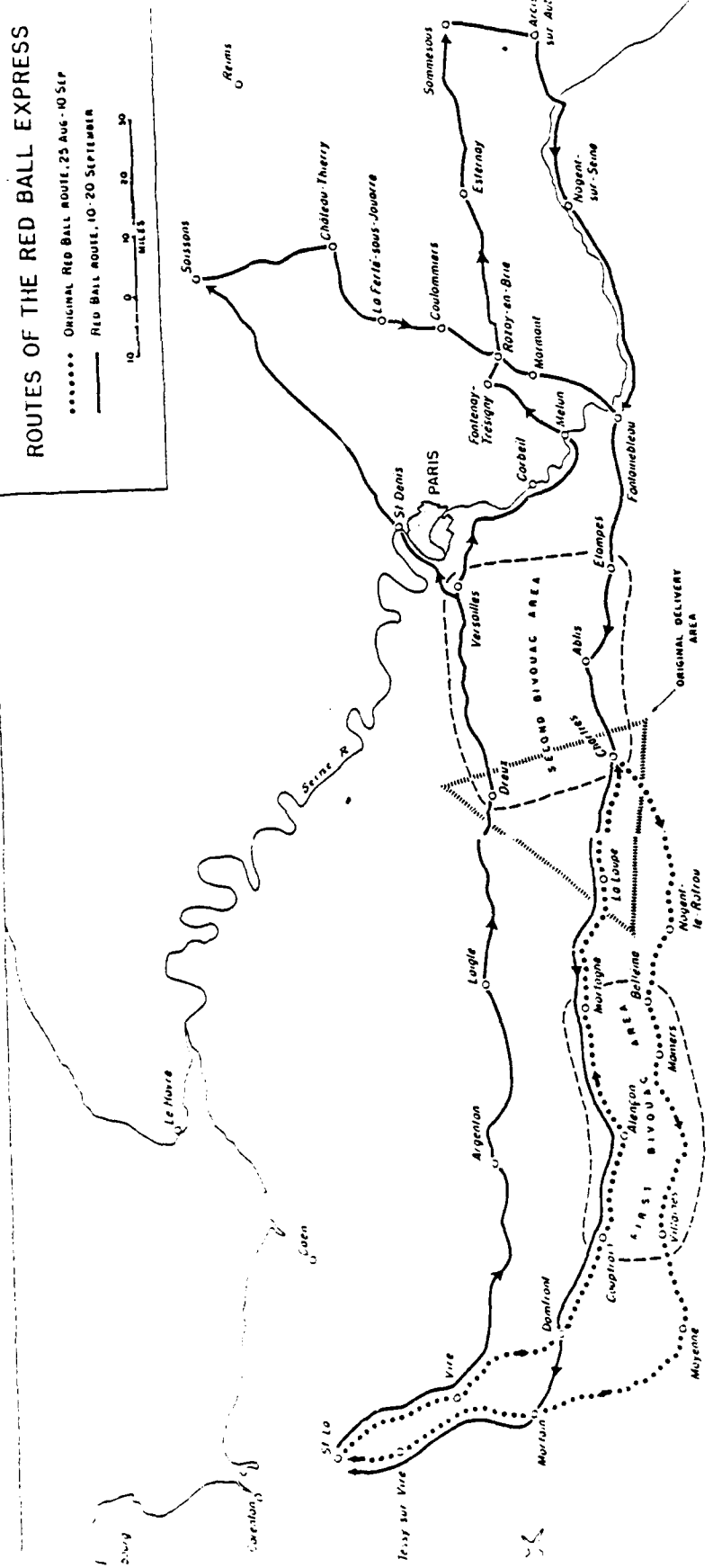
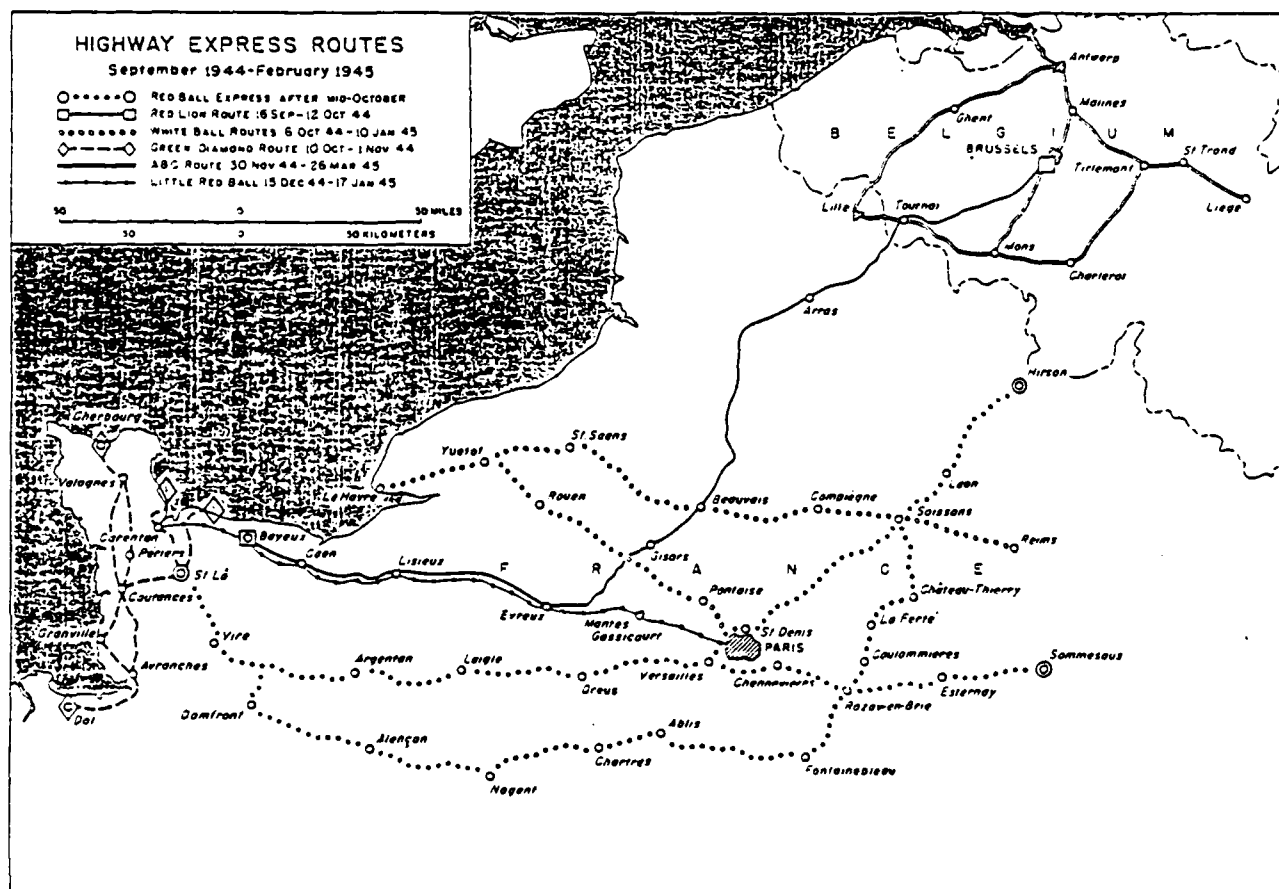


FIGURE 1 SKETCH OF IMPROVISED MULBERRY COMPONENTS (61)

ROUTES OF THE RED BALL EXPRESS  
 ..... ORIGINAL RED BALL ROUTE, 25 AUG-10 SEP  
 ——— RED BALL ROUTE, 10-20 SEPTEMBER  
 10 0 10 20 30  
 MILES



MAP 2 ROUTE OF RED BALL EXPRESS PHASES I AND II (62)



MAP 3 HIGHWAY EXPRESS ROUTES (63)



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